

# PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2001-326419

(43)Date of publication of application : 22.11.2001

(51)Int.Cl.

H01S 5/0683  
B41J 2/44  
G02B 6/122  
G02B 26/10  
H01L 31/12  
H01S 5/026

(21)Application number : 2000-146110

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(22)Date of filing : 18.05.2000

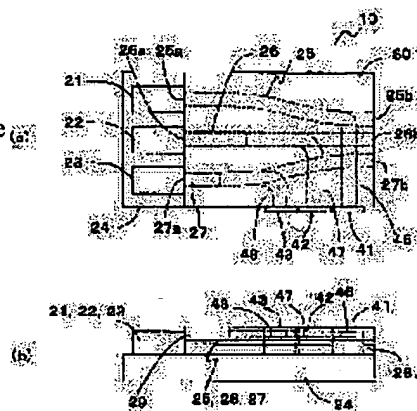
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## (54) OPTICAL MODULE AND LIGHT SOURCE DEVICE

### (57)Abstract:

**PROBLEM TO BE SOLVED:** To provide an optical module in which the quantity of light of a radiated luminous flux can be adjusted precisely even during the scanning of a scanning line and which is small and of a simple structure, and to provide a light source device.

**SOLUTION:** The optical module is provided with waveguides 25, 26, 26 wherein beams of incident light which are radiated from light sources 21, 22, 23 and which are incident from incident faces 25a 26b 27a are guided to outgoing faces 25b, 26b, 27b. The optical module is provided with waveguides 46, 47, 48 which are arranged so as to be adjacent to the waveguides 25, 26, 27 and which take into a part of luminous fluxes passing inside the waveguides 25, 26, 27. The optical module is provided with light receiving elements 41, 42, 43 which receive the luminous fluxes taken into the waveguides 46, 47, 48 and which detect quantities of the beams of incident light. Based on the quantities of the beams of incident light which are detected by the light receiving elements 41, 42, 43, outputs of the light sources 21, 22, 23 are made variable.



## LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

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**CLAIMS**

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**[Claim(s)]**

[Claim 1] The optical module characterized by branching the flux of light in the waveguide which leads the incident light which carried out incidence from plane of incidence to an outgoing radiation side by the optical directional coupler, and enabling it to detect the branched quantity of light by the photo detector.

[Claim 2] The optical module characterized by having the 1st waveguide which leads the incident light which carried out incidence from plane of incidence to an outgoing radiation side, the 2nd waveguide which incorporates a part of flux of light which is approached and allotted to the 1st waveguide and passes along the inside of the 1st waveguide, and the photo detector which receives the flux of light incorporated by the 2nd waveguide, and detects the quantity of light.

[Claim 3] The optical module characterized by having the photo detector which incorporates a part of flux of light which is approached and allotted to the waveguide which leads the incident light which carried out incidence to an outgoing radiation side, and said waveguide from plane of incidence, and passes along the inside of said waveguide, and detects the quantity of light.

[Claim 4] Light equipment characterized by having an optical module according to claim 1 to 3, the light source which irradiates the flux of light at said plane of incidence, and the control section which controls the output of said light source based on the detection result of said photo detector.

[Claim 5] Light equipment according to claim 4 characterized by preparing said optical module and said light source in one.

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DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the optical module and light equipment which can feed back and adjust the output of the light source especially about the optical module and light equipment which inject the light from the light source through waveguide.

[0002]

[Description of the Prior Art] A laser beam printer and a copying machine scan the flux of light injected from the light source, and write in a photo conductor. Moreover, it can scan now at a high speed by condensing in the location where the hoop direction of a photo conductor differs from shaft orientations using two or more flux of lights. In order to approach and to inject two or more flux of lights, light equipment has the optical module using waveguide as shown in the top view and side elevation of drawing 8 (a) and (b).

[0003] The lower cladding layer 28 is formed on a substrate 24, and, as for the optical module 30, waveguides 25, 26, and 27 are formed on the lower cladding layer 28. The upper part of waveguides 25, 26, and 27 is covered with the up cladding layer 29. The up cladding layer 29 and the lower cladding layer 28 have a low refractive index from waveguides 25, 26, and 27, shut up the flux of light which carried out incidence from plane of incidence 25a, 26a, and 27a, and guide waves to the outgoing radiation sides 25b, 26b, and 27b.

[0004] On the substrate 24, the light sources 21, 22, and 23 are formed at one. The light sources 21, 22, and 23 consist of semiconductor laser as shown in drawing 9, and are combined with the plane of incidence 25a, 26a, and 27a of waveguides 25, 26, and 27, respectively.

[0005] In drawing 9, on the substrate 12 of semiconductor laser, the barrier layer 14 inserted into the lower cladding layer 13 and the up cladding layer 15 is formed, and electrodes 11 and 16 are arranged on the inferior surface of tongue of a substrate 12, and the top face of the up cladding layer 15. The flux of lights L1 and L2 are injected by impressing an electrical potential difference between an electrode 11 and 16 from the points 14a and 14b (14a is un-illustrating) formed in the 2nd page of a barrier layer 14 emitting light.

[0006] The flux of light L1 from emitting light point 14a is injected towards the plane of incidence 25a, 26a, and 27a of waveguides 25, 26, and 27, and is used for the store of a photo conductor. The flux of light L2 injected from emitting light point 14b is irradiated by the photo detector which is not illustrated. A photo detector detects the quantity of light which received light, and APC (Automatic Power Control) adjustment is performed by the control section (un-illustrating) based on the detection result.

[0007] The quantity of light of the flux of light which the drive current of semiconductor laser is changed, negates fluctuation of the luminescence reinforcement resulting from change of the ambient temperature of semiconductor laser etc. by this, and is injected from the light sources 21, 22, and 23 is fixed. Consequently, the stripes produced in a formation image can be prevented now.

[0008]

[Problem(s) to be Solved by the Invention] However, since the coefficient of thermal expansion of each part article has a difference according to the above-mentioned conventional light equipment 10, if fluctuation of ambient temperature etc. arises, the relative position of each waveguides 25, 26, and 27 and each light sources 21, 22, and 23 will shift, and the joint effectiveness of the optical module 30 and the light sources 21, 22, and 23 will be changed.

[0009] APC adjustment by the control section is performed based on the flux of light L2 injected from the light sources 21, 22, and 23, and fluctuation of the quantity of light of the flux of light passing through the inside of the waveguides 25 and 26 accompanying fluctuation of joint effectiveness and 27 cannot be detected. For this reason, the quantity of light injected from waveguides 25, 26, and 27 could not be fixed, but there was a problem which cannot form a good image. Moreover, since joint effectiveness is changed not only when combining the direct light source with the optical module 30, but when combining with an optical module an optical fiber, prism, etc. to which the flux of light from the light source is led, there is same problem.

[0010] Moreover, the light beam write-in equipment which detects fluctuation of the quantity of light of the flux of light is indicated by JP,9-230259,A by the sensor which detects the synchronization for scanning a photo conductor. However, according to this approach, in irradiating two or more flux of lights at a photo conductor, it is necessary to enlarge a sensor by the gap of the condensing location of each flux of light, and there is a problem to which light beam write-in equipment

becomes large-sized. Moreover, since the quantity of light is detected, for example at the head of each scan line, there is also a problem which cannot adjust the quantity of light during the scan of a scan line.

[0011] This invention aims at offering the optical module and light equipment of small and easy structure while it can adjust correctly the quantity of light of the flux of light injected even if a scan line is scanning.

[0012]

[Means for Solving the Problem] Invention indicated by claim 1 in order to attain the above-mentioned purpose is characterized by branching the flux of light in the waveguide which leads the incident light which carried out incidence from plane of incidence to an outgoing radiation side by the optical directional coupler, and enabling it to detect the branched quantity of light by the photo detector.

[0013] According to this configuration, the flux of light which carries out incidence from plane of incidence is led to an outgoing radiation side by waveguide, and is injected. Moreover, branching of optical power is performed by the optical directional coupler within waveguide, the flux of light of a fixed rate is taken out, and this flux of light branches, receives light by the photo detector, and detects the quantity of light of branching light. And degradation of joint effectiveness, such as the light source combined with plane of incidence and an optical fiber, can be negated now by adjusting the output of the light source based on the detected quantity of light.

[0014] Moreover, invention indicated by claim 2 is characterized by having the 1st waveguide which leads the incident light which carried out incidence from plane of incidence to an outgoing radiation side, the 2nd waveguide which incorporates a part of flux of light which is approached and allotted to the 1st waveguide and passes along the inside of the 1st waveguide, and the photo detector which receives the flux of light incorporated by the 2nd waveguide, and detects the quantity of light.

[0015] According to this configuration, the flux of light which carries out incidence from plane of incidence is led to an outgoing radiation side by the 1st waveguide, and is injected. Moreover, since the 1st and 2nd waveguide approaches and is allotted, this a part of flux of light passing through the inside of the 1st waveguide shifts to the 2nd waveguide, and the quantity of light of the flux of light which receives light by the photo detector and passes along the 2nd waveguide is detected. And degradation of joint effectiveness, such as the light source combined with plane of incidence and an optical fiber, can be negated now by adjusting the output of the light source based on the detected quantity of light.

[0016] Moreover, invention indicated by claim 3 is characterized by having the photo detector which incorporates a part of flux of light which is approached and allotted to the waveguide which leads the incident light which carried out incidence to an outgoing radiation side, and said waveguide from plane of incidence, and passes along the inside of said waveguide, and detects the quantity of light.

[0017] According to this configuration, the flux of light which carries out incidence from plane of incidence is led to an outgoing radiation side by waveguide, and is injected. Moreover, since waveguide and a photo detector approach and are allotted, this a part of flux of light passing through the inside of waveguide is incorporated by the photo detector, and the quantity of light of the incorporated flux of light is detected. And degradation of joint effectiveness, such as the light source combined with plane of incidence and an optical fiber, can be negated now by adjusting the output of the light source based on the detected quantity of light.

[0018] Moreover, invention indicated by claim 4 is characterized by having an optical module according to claim 1 to 3, the light source which irradiates the flux of light at said plane of incidence, and the control section which controls the output of said light source based on the detection result of said photo detector.

[0019] According to this configuration, incidence of the flux of light injected from the light source is carried out from plane of incidence, and it is led to an outgoing radiation side by waveguide, and is injected as the secondary light source. Moreover, this flux of light branches by the optical directional coupler within waveguide, branching light is received by the photo detector, and the quantity of light is detected. The output of the light source is adjusted by the control section so that the quantity of light of the secondary light source may become fixed based on the detected quantity of light. Furthermore, if this configuration is applied to the light beam write-in equipment by the optical module equipped with two or more waveguides, since the quantity of light injected from each waveguide is controllable, respectively, the stable writing is realizable.

[0020] Moreover, invention indicated by claim 5 is characterized by preparing said optical module and said light source in one in the light equipment indicated by claim 4.

[0021]

[Embodiment of the Invention] The operation gestalt of this invention is explained with reference to a drawing below. About drawing 8 of the conventional example and the same part as drawing 9 of explanation, the same sign is attached for convenience. Drawing 1 is the outline perspective view showing light beam write-in equipment equipped with the light equipment of the 1st operation gestalt. Light beam write-in equipment 1 is carried in a laser beam printer, a digital copier, etc., and can form an image now.

[0022] The light source is built in light equipment 10, and two or more flux of lights from which a condensing location differs are injected. The flux of light injected from light equipment 10 irradiates the polygon mirror 3, after being collimated by the collimator lens 2. The flux of light reflected by the polygon mirror 3 is scanned with rotation of the polygon mirror 3. After fixing a scan speed with the scan lens 4, by connecting a focus on a photo conductor (un-illustrating), the request location of a photo conductor is exposed and writing is performed.

[0023] Moreover, the flux of light reflected by the polygon mirror 3 irradiates the reflective mirror 5 in the head location of each scan line. The flux of light reflected by the reflective mirror 5 is caught by the photo sensor 6, and can detect now the synchronization of two or more flux of lights.

[0024] Light equipment 10 has the optical module 30 as shown in the top view and side elevation of drawing 2 (a) and (b). The lower cladding layer 28 is formed on a substrate 24, and, as for the optical module 30, waveguides 25, 26, and 27 are formed on the lower cladding layer 28. The waveguides 46, 47, and 48 to which a part approaches and stands face to face against waveguides 25, 26, and 27 are formed in the top face of waveguides 25, 26, and 27.

[0025] The upper part of waveguides 25, 26, and 27 and waveguides 46, 47, and 48 is covered with the up cladding layer 29. In fact, in order to secure spacing of Hazama of waveguides 25, 26, and 27 and waveguides 46, 47, and 48, the up cladding layer 29 is formed in 2 steps after formation of waveguides 46, 47, and 48 the formation back of waveguides 25, 26, and 27.

[0026] The up cladding layer 29 and the lower cladding layer 28 have a refractive index lower than waveguides 25, 26, 27, 46, 47, and 48. The flux of light incorporated by waveguides 46, 47, and 48 is guided to photo detectors 41, 42, and 43 so that the flux of light which carried out incidence from plane of incidence 25a, 26a, and 27a may be shut up by this and it may guide waves and mention later to the outgoing radiation sides 25b, 26b, and 27b.

[0027] Since waveguides 25, 26, and 27 and waveguides 46, 47, and 48 approach and it is allotted, a part of flux of light which passes along waveguides 25, 26, and 27 shifts to waveguides 46, 47, and 48. This phenomenon is explained with reference to drawing 3 (a) and (b) about waveguide 25 and waveguide 46. Here, drawing 3 (a) is a top view and (b) is a side elevation.

[0028] If waveguide 25 and waveguide 46 set to L die length (henceforth "bond length") approached and allotted and set the propagation constant of  $\beta_{25}$  and an odd symmetric mode to  $\beta_{46}$  for the propagation constant of the even symmetric mode of waveguides 25 and 46, the phase contrast in each mode of the flux of light which passes along waveguide 25 will be set to  $L(\beta_{25}-\beta_{46})$ . If bond length L satisfies the following formula (1), the phase contrast in each mode will be set to  $\pi$ , and the optical power of the guided wave light L3 passing through the inside of waveguide 25 will serve as the branching light L4 which is taken out 100% theoretically and passes along the inside of waveguide 46. Thereby, waveguide 25 and waveguide 46 constitute an optical directional coupler.

[0029]  $L = \pi / (\beta_{25} - \beta_{46}) \dots (1)$

[0030] Here, when bond length L is made into a different value from  $\pi / (\beta_{25} - \beta_{46})$ , the optical power of the guided wave light L3 passing through the inside of waveguide 25 is taken out at a fixed rate, and passes along the inside of waveguide 46.

[0031] Moreover, the coupling coefficient  $\kappa$  of waveguide 25 and waveguide 46 is expressed with the following formula (2).

[0032]  $\kappa = (\beta_{25} - \beta_{46}) / 2 \dots (2)$

[0033] The relation between propagation constant  $\beta_{25}$ ,  $\beta_{46}$  and a coupling coefficient  $\kappa$  (axis of ordinate), and the waveguide spacing g (axis of abscissa) is shown in drawing 4. Drawing 4 (a) and (b) show the case where the cross-section configuration of two waveguides is the same, and the case where it differs. According to these drawings, since propagation constant  $\beta_{25}$  and  $\beta_{46}$  change with waveguide spacing g, as a broken line shows, a coupling coefficient  $\kappa$  changes among drawing. Therefore, a part of guided wave light L3 can be branched by choosing appropriately bond length L or the waveguide spacing g with a desired branching ratio (ratio of the optical power of the branching light L4 to the optical power of the guided wave light L3).

[0034] In above-mentioned drawing 2, the photo detectors 41, 42, and 43 which consist of a photodiode etc. are combined with the end face of each waveguides 46, 47, and 48. Thereby, the branching light L4 is received and light income can be detected now.

[0035] Such an optical module 30 can be manufactured by the following approaches. First, on the substrate 24 which consists of silicon etc., doping a fluorine by CVD, 7 micrometers of quartzes are deposited and the lower cladding layer 28 is formed. Next, 5 micrometers of quartzes are deposited, without doping by CVD. And after carrying out patterning to a predetermined configuration according to a FOTORISO process, waveguides 25, 26, and 27 are formed by performing reactive-ion-etching processing.

[0036] Next, 2 micrometers of quartzes are deposited doping a fluorine, and 5 micrometers of quartzes are deposited, without doping by CVD. And after carrying out patterning to a predetermined configuration according to a FOTORISO process, waveguides 46, 47, and 48 are formed by performing reactive-ion-etching processing. Next, doping a fluorine, 7 micrometers of quartzes are deposited and the up cladding layer 29 is formed.

[0037] And photo detectors 41, 42, and 43 are fixed to the end face of waveguides 46, 47, and 48. Thereby, the optical module 30 can be obtained. The optical module 30 of this operation gestalt acquired by the above-mentioned manufacture approach is shown below.

[0038]

The ingredient of a substrate: 1mm [0039] : Silicon Ingredient of waveguide : Quartz Effective refractive index  $N_{eff}$  of waveguide : 1.459 The refractive-index difference of an up cladding layer, a lower cladding layer, and waveguide: 0.3% Cross section of waveguide : 5micrometerx5micrometer Waveguide spacing g : 2 micrometers Bond length L When the wavelength  $\lambda$  of the guided wave light L3 was 780nm, the optical module 30 with which the branching ratio by the optical directional coupler becomes 5% was obtained by this.

[0040] Moreover, in drawing 2, the light sources 21, 22, and 23 are formed on the substrate 24 at the optical module 30 and one. The light sources 21, 22, and 23 consist of semiconductor laser as shown in above-mentioned drawing 9, and are combined with the plane of incidence 25a, 26a, and 27a of waveguides 25, 26, and 27, respectively.

[0041] If the configuration of light equipment 10 is shown in the block diagram of drawing 5, light equipment 10 has the control section 31 which controls the output of the light sources 21, 22, and 23. The flux of light injected from the light

sources 21, 22, and 23 guides waveguides 25, 26, and 27, and branches by the optical directional coupler. And the quantity of light of each branching light L4 (refer to drawing 3 (b)) is detected by photo detectors 41, 42, and 43.

[0042] The result detected by photo detectors 41, 42, and 43 is compared by the predetermined quantity of light data and the predetermined comparator 32 of branching light which were memorized by the storage section 34. As a result of the comparison by the comparator 32, when there is no quantity of light of branching light in the predetermined range, it judges that the flux of light of the predetermined quantity of light is not injected from the optical module 30, and adjustable [ of the drive current of the light sources 21, 22, and 23 ] is carried out, and adjustable [ of the output of the light sources 21, 22, and 23 ] is carried out by the mechanical component 33.

[0043] When the quantity of light of branching light is predetermined within the limits, a mechanical component 33 maintains the drive current of the light sources 21, 22, and 23. Thereby, from the outgoing radiation sides 25b, 26b, and 27b of waveguides 25, 26, and 27, it is adjusted so that the flux of light of the fixed quantity of light may always be injected.

[0044] According to this operation gestalt, the waveguides 46, 47, and 48 prepared in waveguides 25, 26, and 27 by approaching constitute an optical directional coupler, the guided wave light L3 is branched, and the quantity of light of the light sources 21, 22, and 23 is adjusted based on the quantity of light of the branching light L4 detected by the photo detectors 41, 42, and 43 formed in one at the optical module 30. For this reason, adjustment becomes possible, even if it can simplify the configuration for quantity of light adjustment small and a scan line is scanning it.

[0045] Moreover, even if it is the time of the joint effectiveness of the light sources 21, 22, and 23 and the optical module 30 by change of an ambient temperature etc. falling by these relative-position change, the outgoing radiation light by which follows in footsteps of it and outgoing radiation is carried out from the optical module 30 is uniformly maintainable.

[0046] Next, drawing 6 (a) and (b) are the top views and side elevations showing the light equipment 10 of the 2nd operation gestalt. The same sign is given to the same part as the 1st operation gestalt shown in above-mentioned drawing 2 of explanation for convenience. A different point from the 1st operation gestalt is a point that change to photo detectors 41, 42, and 43, and one photo detector 44 is formed, in order to detect the quantity of light of the branching light of each waveguides 25, 26, and 27. Other configurations are the same as that of the 1st operation gestalt.

[0047] In case the quantity of light injected from each waveguides 25, 26, and 27 is detected according to this operation gestalt, a photo detector 44 can detect the quantity of light of each branching light by driving the light sources 21, 22, and 23 separately. And the quantity of light of the flux of light which adjusts the output of the light sources 21, 22, and 23, and is injected by the control section 31 (refer to drawing 5) from the optical module 30 is uniformly maintainable.

[0048] Next, drawing 7 (a) and (b) are the top views and side elevations showing the light equipment 10 of the 3rd operation gestalt. The same sign is given to the same part as the 1st and 2nd operation gestalt shown in above-mentioned drawing 2 of explanation, and drawing 6 for convenience. A different point from the 2nd operation gestalt did not form waveguides 46, 47, and 48, but has prepared crevice 29a to which a base approaches and stands face to face against waveguides 25, 26, and 27 in the up cladding layer 29. And it is the point that one photo detector 49 is allotted to the crevice 29a. Other configurations are the same as that of the 2nd operation gestalt.

[0049] After crevice 29a forms the up cladding layer 29, it can be formed by carrying out patterning to a predetermined configuration and performing reactive-ion-etching processing. Since the base and waveguides 25, 26, and 27 of crevice 29a approach and it is allotted, a part of guided wave light L3 (refer to drawing 3) is incorporated by the photo detector 49 according to the phase contrast of the odd symmetric mode of the flux of light and even symmetric mode which pass along waveguides 25, 26, and 27 as well as the 1st and 2nd operation gestalt.

[0050] Therefore, the optical directional coupler is constituted by waveguides 25, 26, and 27 and the photo detector 49. Thereby, the same effectiveness as the 1st and 2nd operation gestalt can be acquired. Furthermore, since waveguides 46, 47, and 48 are not formed like the 1st and 2nd operation gestalt, a photo detector 49 can be allotted near each outgoing radiation sides 25b, 26b, and 27b. Consequently, optical reinforcement just before carrying out outgoing radiation can be detected, and the detection precision of fluctuation of outgoing radiation light can be raised.

[0051] Moreover, in this operation gestalt, like the 1st operation gestalt, if two or more photo detectors are prepared corresponding to each waveguides 25, 26, and 27, it will become possible to control the output of each light sources 21, 22, and 23 to coincidence.

[0052] In the 1st explained above - the 3rd operation gestalt, although the optical module 30 and the light sources 21, 22, and 23 are constituted in one, these may be formed in another object, an optical fiber and prism may be combined with the optical module 30, and incidence of the flux of light from the light source may be carried out. moreover, although the light sources 21, 22, and 23 are established for every [ each waveguides 25 and 26 and ] 27, it branches from the one light source -- making -- each plane of incidence 25a and 26a -- it may be made to carry out 27a incidence. In this case, it is needed separately in an accommodation means to adjust the quantity of light of each flux of light after branching.

[0053]

[Effect of the Invention] According to this invention, two waveguides prepared by approaching or the waveguide prepared by approaching, and a photo detector can constitute an optical directional coupler, guided wave light can be branched, and the output of the light source can be adjusted based on the quantity of light of the branching light detected by the photo detector. For this reason, even if it can simplify the configuration for the quantity of light adjustment of the flux of light by which outgoing radiation is carried out small and a scan line is scanning it from an optical module, it can adjust.

[0054] Moreover, even if it is the time of joint effectiveness falling by relative-position change with the light source etc. and the optical module by change of an ambient temperature etc., the outgoing radiation light by which follows in footsteps of it

and outgoing radiation is carried out from an optical module is uniformly maintainable correctly.

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**TECHNICAL FIELD**

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[Field of the Invention] This invention relates to the optical module and light equipment which can feed back and adjust the output of the light source especially about the optical module and light equipment which inject the light from the light source through waveguide.

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PRIOR ART

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[Description of the Prior Art] A laser beam printer and a copying machine scan the flux of light injected from the light source, and write in a photo conductor. Moreover, it can scan now at a high speed by condensing in the location where the hoop direction of a photo conductor differs from shaft orientations using two or more flux of lights. In order to approach and to inject two or more flux of lights, light equipment has the optical module using waveguide as shown in the top view and side elevation of drawing 8 (a) and (b).

[0003] The lower cladding layer 28 is formed on a substrate 24, and, as for the optical module 30, waveguides 25, 26, and 27 are formed on the lower cladding layer 28. The upper part of waveguides 25, 26, and 27 is covered with the up cladding layer 29. The up cladding layer 29 and the lower cladding layer 28 have a low refractive index from waveguides 25, 26, and 27, shut up the flux of light which carried out incidence from plane of incidence 25a, 26a, and 27a, and guide waves to the outgoing radiation sides 25b, 26b, and 27b.

[0004] On the substrate 24, the light sources 21, 22, and 23 are formed at one. The light sources 21, 22, and 23 consist of semiconductor laser as shown in drawing 9, and are combined with the plane of incidence 25a, 26a, and 27a of waveguides 25, 26, and 27, respectively.

[0005] In drawing 9, on the substrate 12 of semiconductor laser, the barrier layer 14 inserted into the lower cladding layer 13 and the up cladding layer 15 is formed, and electrodes 11 and 16 are arranged on the inferior surface of tongue of a substrate 12, and the top face of the up cladding layer 15. The flux of lights L1 and L2 are injected by impressing an electrical potential difference between an electrode 11 and 16 from the points 14a and 14b (14a is un-illustrating) formed in the 2nd page of a barrier layer 14 emitting light.

[0006] The flux of light L1 from emitting light point 14a is injected towards the plane of incidence 25a, 26a, and 27a of waveguides 25, 26, and 27, and is used for the store of a photo conductor. The flux of light L2 injected from emitting light point 14b is irradiated by the photo detector which is not illustrated. A photo detector detects the quantity of light which received light, and APC (Automatic Power Control) adjustment is performed by the control section (un-illustrating) based on the detection result.

[0007] The quantity of light of the flux of light which the drive current of semiconductor laser is changed, negates fluctuation of the luminescence reinforcement resulting from change of the ambient temperature of semiconductor laser etc. by this, and is injected from the light sources 21, 22, and 23 is fixed. Consequently, the stripes produced in a formation image can be prevented now.

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**EFFECT OF THE INVENTION**

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[Effect of the Invention] According to this invention, two waveguides prepared by approaching or the waveguide prepared by approaching, and a photo detector can constitute an optical directional coupler, guided wave light can be branched, and the output of the light source can be adjusted based on the quantity of light of the branching light detected by the photo detector. For this reason, even if it can simplify the configuration for the quantity of light adjustment of the flux of light by which outgoing radiation is carried out small and a scan line is scanning it from an optical module, it can adjust.

[0054] Moreover, even if it is the time of joint effectiveness falling by relative-position change with the light source etc. and the optical module by change of an ambient temperature etc., the outgoing radiation light by which follows in footsteps of it and outgoing radiation is carried out from an optical module is uniformly maintainable correctly.

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**TECHNICAL PROBLEM**

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[Problem(s) to be Solved by the Invention] However, since the coefficient of thermal expansion of each part article has a difference according to the above-mentioned conventional light equipment 10, if fluctuation of ambient temperature etc. arises, the relative position of each waveguides 25, 26, and 27 and each light sources 21, 22, and 23 will shift, and the joint effectiveness of the optical module 30 and the light sources 21, 22, and 23 will be changed.

[0009] APC adjustment by the control section is performed based on the flux of light L2 injected from the light sources 21, 22, and 23, and fluctuation of the quantity of light of the flux of light passing through the inside of the waveguides 25 and 26 accompanying fluctuation of joint effectiveness and 27 cannot be detected. For this reason, the quantity of light injected from waveguides 25, 26, and 27 could not be fixed, but there was a problem which cannot form a good image. Moreover, since joint effectiveness is changed not only when combining the direct light source with the optical module 30, but when combining with an optical module an optical fiber, prism, etc. to which the flux of light from the light source is led, there is same problem.

[0010] Moreover, the light beam write-in equipment which detects fluctuation of the quantity of light of the flux of light is indicated by JP,9-230259,A by the sensor which detects the synchronization for scanning a photo conductor. However, according to this approach, in irradiating two or more flux of lights at a photo conductor, it is necessary to enlarge a sensor by the gap of the condensing location of each flux of light, and there is a problem to which light beam write-in equipment becomes large-sized. Moreover, since the quantity of light is detected, for example at the head of each scan line, there is also a problem which cannot adjust the quantity of light during the scan of a scan line.

[0011] This invention aims at offering the optical module and light equipment of small and easy structure while it can adjust correctly the quantity of light of the flux of light injected even if a scan line is scanning.

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MEANS

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[Means for Solving the Problem] Invention indicated by claim 1 in order to attain the above-mentioned purpose is characterized by branching the flux of light in the waveguide which leads the incident light which carried out incidence from plane of incidence to an outgoing radiation side by the optical directional coupler, and enabling it to detect the branched quantity of light by the photo detector.

[0013] According to this configuration, the flux of light which carries out incidence from plane of incidence is led to an outgoing radiation side by waveguide, and is injected. Moreover, branching of optical power is performed by the optical directional coupler within waveguide, the flux of light of a fixed rate is taken out, and this flux of light branches, receives light by the photo detector, and detects the quantity of light of branching light. And degradation of joint effectiveness, such as the light source combined with plane of incidence and an optical fiber, can be negated now by adjusting the output of the light source based on the detected quantity of light.

[0014] Moreover, invention indicated by claim 2 is characterized by having the 1st waveguide which leads the incident light which carried out incidence from plane of incidence to an outgoing radiation side, the 2nd waveguide which incorporates a part of flux of light which is approached and allotted to the 1st waveguide and passes along the inside of the 1st waveguide, and the photo detector which receives the flux of light incorporated by the 2nd waveguide, and detects the quantity of light.

[0015] According to this configuration, the flux of light which carries out incidence from plane of incidence is led to an outgoing radiation side by the 1st waveguide, and is injected. Moreover, since the 1st and 2nd waveguide approaches and is allotted, this a part of flux of light passing through the inside of the 1st waveguide shifts to the 2nd waveguide, and the quantity of light of the flux of light which receives light by the photo detector and passes along the 2nd waveguide is detected. And degradation of joint effectiveness, such as the light source combined with plane of incidence and an optical fiber, can be negated now by adjusting the output of the light source based on the detected quantity of light.

[0016] Moreover, invention indicated by claim 3 is characterized by having the photo detector which incorporates a part of flux of light which is approached and allotted to the waveguide which leads the incident light which carried out incidence to an outgoing radiation side, and said waveguide from plane of incidence, and passes along the inside of said waveguide, and detects the quantity of light.

[0017] According to this configuration, the flux of light which carries out incidence from plane of incidence is led to an outgoing radiation side by waveguide, and is injected. Moreover, since waveguide and a photo detector approach and are allotted, this a part of flux of light passing through the inside of waveguide is incorporated by the photo detector, and the quantity of light of the incorporated flux of light is detected. And degradation of joint effectiveness, such as the light source combined with plane of incidence and an optical fiber, can be negated now by adjusting the output of the light source based on the detected quantity of light.

[0018] Moreover, invention indicated by claim 4 is characterized by having an optical module according to claim 1 to 3, the light source which irradiates the flux of light at said plane of incidence, and the control section which controls the output of said light source based on the detection result of said photo detector.

[0019] According to this configuration, incidence of the flux of light injected from the light source is carried out from plane of incidence, and it is led to an outgoing radiation side by waveguide, and is injected as the secondary light source. Moreover, this flux of light branches by the optical directional coupler within waveguide, branching light is received by the photo detector, and the quantity of light is detected. The output of the light source is adjusted by the control section so that the quantity of light of the secondary light source may become fixed based on the detected quantity of light. Furthermore, if this configuration is applied to the light beam write-in equipment by the optical module equipped with two or more waveguides, since the quantity of light injected from each waveguide is controllable, respectively, the stable writing is realizable.

[0020] Moreover, invention indicated by claim 5 is characterized by preparing said optical module and said light source in one in the light equipment indicated by claim 4.

[0021]

[Embodiment of the Invention] The operation gestalt of this invention is explained with reference to a drawing below. About drawing 8 of the conventional example and the same part as drawing 9 of explanation, the same sign is attached for convenience. Drawing 1 is the outline perspective view showing light beam write-in equipment equipped with the light equipment of the 1st operation gestalt. Light beam write-in equipment 1 is carried in a laser beam printer, a digital copier, etc., and can form an image now.

[0022] The light source is built in light equipment 10, and two or more flux of lights from which a condensing location differs

are injected. The flux of light injected from light equipment 10 irradiates the polygon mirror 3, after being collimated by the collimator lens 2. The flux of light reflected by the polygon mirror 3 is scanned with rotation of the polygon mirror 3. After fixing a scan speed with the scan lens 4, by connecting a focus on a photo conductor (un-illustrating), the request location of a photo conductor is exposed and writing is performed.

[0023] Moreover, the flux of light reflected by the polygon mirror 3 irradiates the reflective mirror 5 in the head location of each scan line. The flux of light reflected by the reflective mirror 5 is caught by the photo sensor 6, and can detect now the synchronization of two or more flux of lights.

[0024] Light equipment 10 has the optical module 30 as shown in the top view and side elevation of drawing 2 (a) and (b). The lower cladding layer 28 is formed on a substrate 24, and, as for the optical module 30, waveguides 25, 26, and 27 are formed on the lower cladding layer 28. The waveguides 46, 47, and 48 to which a part approaches and stands face to face against waveguides 25, 26, and 27 are formed in the top face of waveguides 25, 26, and 27.

[0025] The upper part of waveguides 25, 26, and 27 and waveguides 46, 47, and 48 is covered with the up cladding layer 29. In fact, in order to secure spacing of Hazama of waveguides 25, 26, and 27 and waveguides 46, 47, and 48, the up cladding layer 29 is formed in 2 steps after formation of waveguides 46, 47, and 48 the formation back of waveguides 25, 26, and 27.

[0026] The up cladding layer 29 and the lower cladding layer 28 have a refractive index lower than waveguides 25, 26, 27, 46, 47, and 48. The flux of light incorporated by waveguides 46, 47, and 48 is guided to photo detectors 41, 42, and 43 so that the flux of light which carried out incidence from plane of incidence 25a, 26a, and 27a may be shut up by this and it may guide waves and mention later to the outgoing radiation sides 25b, 26b, and 27b.

[0027] Since waveguides 25, 26, and 27 and waveguides 46, 47, and 48 approach and it is allotted, a part of flux of light which passes along waveguides 25, 26, and 27 shifts to waveguides 46, 47, and 48. This phenomenon is explained with reference to drawing 3 (a) and (b) about waveguide 25 and waveguide 46. Here, drawing 3 (a) is a top view and (b) is a side elevation.

[0028] If waveguide 25 and waveguide 46 set to L die length (henceforth "bond length") approached and allotted and set the propagation constant of betae and an odd symmetric mode to betao for the propagation constant of the even symmetric mode of waveguides 25 and 46, the phase contrast in each mode of the flux of light which passes along waveguide 25 will be set to L (betae-betao). If bond length L satisfies the following formula (1), the phase contrast in each mode will be set to pi, and the optical power of the guided wave light L3 passing through the inside of waveguide 25 will serve as the branching light L4 which is taken out 100% theoretically and passes along the inside of waveguide 46. Thereby, waveguide 25 and waveguide 46 constitute an optical directional coupler.

[0029]  $L = \pi / (\text{betae} - \text{betao}) \dots (1)$

[0030] Here, when bond length L is made into a different value from  $\pi / (\text{betae} - \text{betao})$ , the optical power of the guided wave light L3 passing through the inside of waveguide 25 is taken out at a fixed rate, and passes along the inside of waveguide 46.

[0031] Moreover, the coupling coefficient kappa of waveguide 25 and waveguide 46 is expressed with the following formula (2).

[0032]  $\text{kappa} = (\text{betae} - \text{betao}) / 2 \dots (2)$

[0033] The relation between propagation constant betae, betao and a coupling coefficient kappa (axis of ordinate), and the waveguide spacing g (axis of abscissa) is shown in drawing 4. Drawing 4 (a) and (b) show the case where the cross-section configuration of two waveguides is the same, and the case where it differs. According to these drawings, since propagation constant betae and betao change with waveguide spacing g, as a broken line shows, a coupling coefficient kappa changes among drawing. Therefore, a part of guided wave light L3 can be branched by choosing appropriately bond length L or the waveguide spacing g with a desired branching ratio (ratio of the optical power of the branching light L4 to the optical power of the guided wave light L3).

[0034] In above-mentioned drawing 2, the photo detectors 41, 42, and 43 which consist of a photodiode etc. are combined with the end face of each waveguides 46, 47, and 48. Thereby, the branching light L4 is received and light income can be detected now.

[0035] Such an optical module 30 can be manufactured by the following approaches. First, on the substrate 24 which consists of silicon etc., doping a fluorine by CVD, 7 micrometers of quartzes are deposited and the lower cladding layer 28 is formed. Next, 5 micrometers of quartzes are deposited, without doping by CVD. And after carrying out patterning to a predetermined configuration according to a FOTORISO process, waveguides 25, 26, and 27 are formed by performing reactive-ion-etching processing.

[0036] Next, 2 micrometers of quartzes are deposited doping a fluorine, and 5 micrometers of quartzes are deposited, without doping by CVD. And after carrying out patterning to a predetermined configuration according to a FOTORISO process, waveguides 46, 47, and 48 are formed by performing reactive-ion-etching processing. Next, doping a fluorine, 7 micrometers of quartzes are deposited and the up cladding layer 29 is formed.

[0037] And photo detectors 41, 42, and 43 are fixed to the end face of waveguides 46, 47, and 48. Thereby, the optical module 30 can be obtained. The optical module 30 of this operation gestalt acquired by the above-mentioned manufacture approach is shown below.

[0038]

The ingredient of a substrate: 1mm [0039] : Silicon Ingredient of waveguide : Quartz Effective refractive index Neff of waveguide : 1.459 The refractive-index difference of an up cladding layer, a lower cladding layer, and waveguide: 0.3% Cross section of waveguide : 5micrometerx5micrometer Waveguide spacing g : 2 micrometers Bond length L When the

wavelength  $\lambda$  of the guided wave light L3 was 780nm, the optical module 30 with which the branching ratio by the optical directional coupler becomes 5% was obtained by this.

[0040] Moreover, in drawing 2, the light sources 21, 22, and 23 are formed on the substrate 24 at the optical module 30 and one. The light sources 21, 22, and 23 consist of semiconductor laser as shown in above-mentioned drawing 9, and are combined with the plane of incidence 25a, 26a, and 27a of waveguides 25, 26, and 27, respectively.

[0041] If the configuration of light equipment 10 is shown in the block diagram of drawing 5, light equipment 10 has the control section 31 which controls the output of the light sources 21, 22, and 23. The flux of light injected from the light sources 21, 22, and 23 guides waveguides 25, 26, and 27, and branches by the optical directional coupler. And the quantity of light of each branching light L4 (refer to drawing 3 (b)) is detected by photo detectors 41, 42, and 43.

[0042] The result detected by photo detectors 41, 42, and 43 is compared by the predetermined quantity of light data and the predetermined comparator 32 of branching light which were memorized by the storage section 34. As a result of the comparison by the comparator 32, when there is no quantity of light of branching light in the predetermined range, it judges that the flux of light of the predetermined quantity of light is not injected from the optical module 30, and adjustable [ of the drive current of the light sources 21, 22, and 23 ] is carried out, and adjustable [ of the output of the light sources 21, 22, and 23 ] is carried out by the mechanical component 33.

[0043] When the quantity of light of branching light is predetermined within the limits, a mechanical component 33 maintains the drive current of the light sources 21, 22, and 23. Thereby, from the outgoing radiation sides 25b, 26b, and 27b of waveguides 25, 26, and 27, it is adjusted so that the flux of light of the fixed quantity of light may always be injected.

[0044] According to this operation gestalt, the waveguides 46, 47, and 48 prepared in waveguides 25, 26, and 27 by approaching constitute an optical directional coupler, the guided wave light L3 is branched, and the quantity of light of the light sources 21, 22, and 23 is adjusted based on the quantity of light of the branching light L4 detected by the photo detectors 41, 42, and 43 formed in one at the optical module 30. For this reason, adjustment becomes possible, even if it can simplify the configuration for quantity of light adjustment small and a scan line is scanning it.

[0045] Moreover, even if it is the time of the joint effectiveness of the light sources 21, 22, and 23 and the optical module 30 by change of an ambient temperature etc. falling by these relative-position change, the outgoing radiation light by which follows in footsteps of it and outgoing radiation is carried out from the optical module 30 is uniformly maintainable.

[0046] Next, drawing 6 (a) and (b) are the top views and side elevations showing the light equipment 10 of the 2nd operation gestalt. The same sign is given to the same part as the 1st operation gestalt shown in above-mentioned drawing 2 of explanation for convenience. A different point from the 1st operation gestalt is a point that change to photo detectors 41, 42, and 43, and one photo detector 44 is formed, in order to detect the quantity of light of the branching light of each waveguides 25, 26, and 27. Other configurations are the same as that of the 1st operation gestalt.

[0047] In case the quantity of light injected from each waveguides 25, 26, and 27 is detected according to this operation gestalt, a photo detector 44 can detect the quantity of light of each branching light by driving the light sources 21, 22, and 23 separately. And the quantity of light of the flux of light which adjusts the output of the light sources 21, 22, and 23, and is injected by the control section 31 (refer to drawing 5) from the optical module 30 is uniformly maintainable.

[0048] Next, drawing 7 (a) and (b) are the top views and side elevations showing the light equipment 10 of the 3rd operation gestalt. The same sign is given to the same part as the 1st and 2nd operation gestalt shown in above-mentioned drawing 2 of explanation, and drawing 6 for convenience. A different point from the 2nd operation gestalt did not form waveguides 46, 47, and 48, but has prepared crevice 29a to which a base approaches and stands face to face against waveguides 25, 26, and 27 in the up cladding layer 29. And it is the point that one photo detector 49 is allotted to the crevice 29a. Other configurations are the same as that of the 2nd operation gestalt.

[0049] After crevice 29a forms the up cladding layer 29, it can be formed by carrying out patterning to a predetermined configuration and performing reactive-ion-etching processing. Since the base and waveguides 25, 26, and 27 of crevice 29a approach and it is allotted, a part of guided wave light L3 (refer to drawing 3) is incorporated by the photo detector 49 according to the phase contrast of the odd symmetric mode of the flux of light and even symmetric mode which pass along waveguides 25, 26, and 27 as well as the 1st and 2nd operation gestalt.

[0050] Therefore, the optical directional coupler is constituted by waveguides 25, 26, and 27 and the photo detector 49. Thereby, the same effectiveness as the 1st and 2nd operation gestalt can be acquired. Furthermore, since waveguides 46, 47, and 48 are not formed like the 1st and 2nd operation gestalt, a photo detector 49 can be allotted near each outgoing radiation sides 25b, 26b, and 27b. Consequently, optical reinforcement just before carrying out outgoing radiation can be detected, and the detection precision of fluctuation of outgoing radiation light can be raised.

[0051] Moreover, in this operation gestalt, like the 1st operation gestalt, if two or more photo detectors are prepared corresponding to each waveguides 25, 26, and 27, it will become possible to control the output of each light sources 21, 22, and 23 to coincidence.

[0052] In the 1st explained above - the 3rd operation gestalt, although the optical module 30 and the light sources 21, 22, and 23 are constituted in one, these may be formed in another object, an optical fiber and prism may be combined with the optical module 30, and incidence of the flux of light from the light source may be carried out. moreover, although the light sources 21, 22, and 23 are established for every [ each waveguides 25 and 26 and ] 27, it branches from the one light source -- making -- each plane of incidence 25a and 26a -- it may be made to carry out 27a incidence. In this case, it is needed separately in an accommodation means to adjust the quantity of light of each flux of light after branching.

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[Translation done.]

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**DESCRIPTION OF DRAWINGS**

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[Brief Description of the Drawings]

[Drawing 1] It is the perspective view showing light beam write-in equipment equipped with the light equipment of the 1st operation gestalt of this invention.

[Drawing 2] It is the top view and side elevation showing the light equipment of the 1st operation gestalt of this invention.

[Drawing 3] It is drawing showing the optical directional coupler of the light equipment of the 1st operation gestalt of this invention.

[Drawing 4] It is drawing showing the relation between the electric-wave constant of the waveguide of the light equipment of the 1st operation gestalt of this invention and a coupling coefficient, and waveguide spacing.

[Drawing 5] It is the block diagram showing the configuration of the light equipment of the 1st operation gestalt of this invention.

[Drawing 6] It is the top view and side elevation showing the light equipment of the 2nd operation gestalt of this invention.

[Drawing 7] It is the top view and side elevation showing the light equipment of the 3rd operation gestalt of this invention.

[Drawing 8] It is the top view and side elevation showing conventional light equipment.

[Drawing 9] It is the perspective view showing the conventional light source.

[Description of Notations]

1 Light Beam Write-in Equipment

2 Collimator Lens

3 Polygon Mirror

4 Scan Lens

5 Reflective Mirror

6 Photo Sensor

10 Light Equipment

11 16 Electrode

12 Substrate

13 Lower Cladding Layer

14 Barrier Layer

15 Up Cladding Layer

21, 22, 23 Light source

24 Substrate

25, 26, 27, 46, 47, 48 Waveguide

28 Lower Cladding Layer

29 Up Cladding Layer

30 Optical Module

31 Control Section

32 Comparator

33 Mechanical Component

34 Storage Section

41, 42, 43, 44, 49 Photo detector

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[Translation done.]



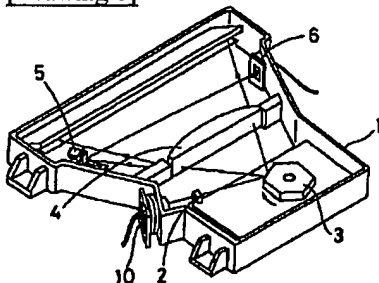
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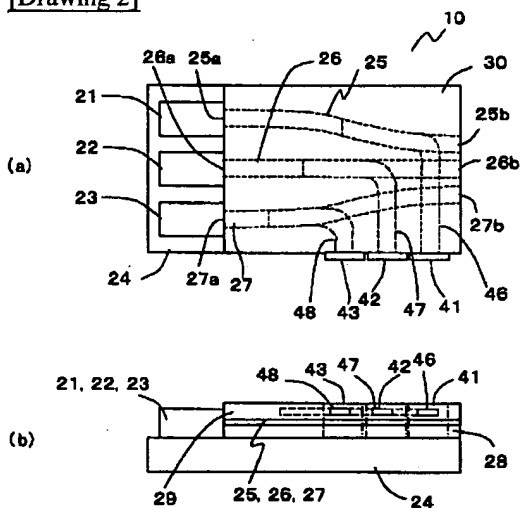
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DRAWINGS

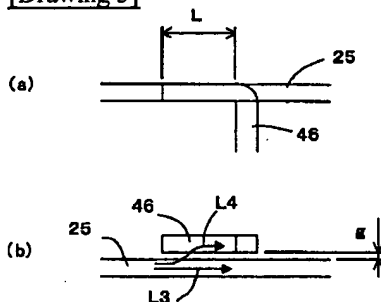
[Drawing 1]



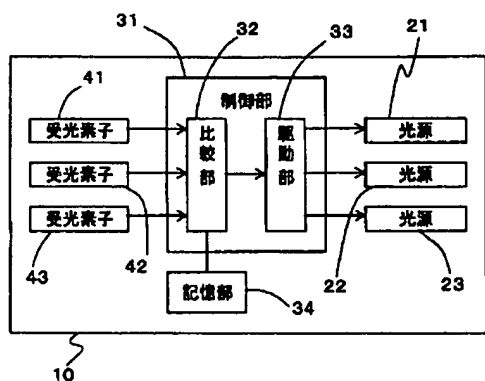
[Drawing 2]



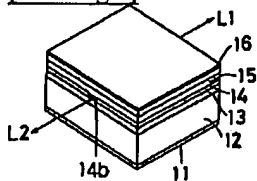
[Drawing 3]



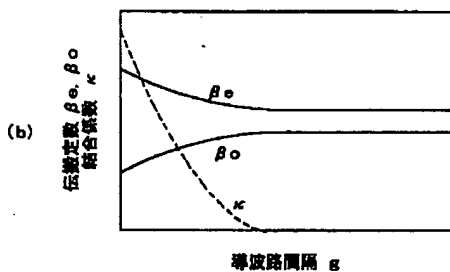
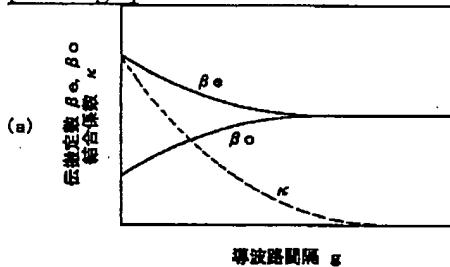
[Drawing 5]



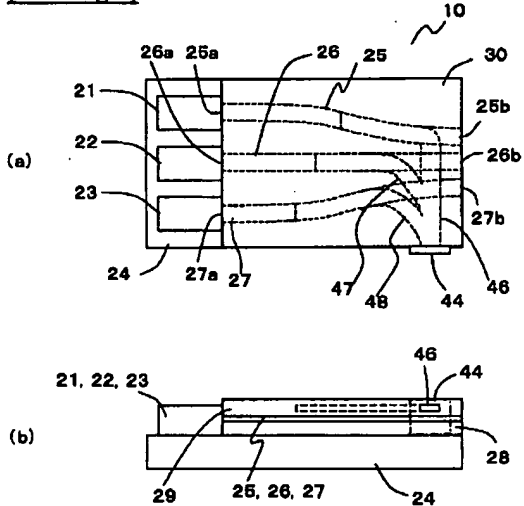
[Drawing 9]



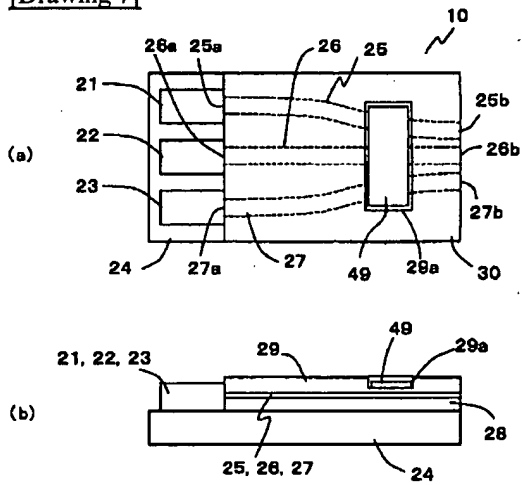
[Drawing 4]



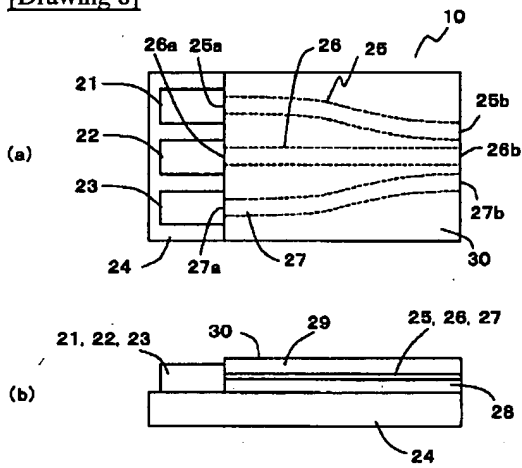
[Drawing 6]



[Drawing 7]



[Drawing 8]



[Translation done.]